Quarterly Report (Q3 2014)

The Earth Institute at Columbia University

Micro-Solar Utilities for Small-Scale Irrigation in Senegal
(Cooperative Agreement No. AID-OAA-A-13-00063)

July 31, 2014

USAID FROM THE AMERICAN PEOPLE | Duke Energy | SWEDEN | OPIC | BMZ Federal Ministry for Economic Cooperation and Development | The Earth Institute Columbia University

Main Activities and Accomplishments:

This quarter was taken up nearly entirely by the procurement of the AC pump controller, PV panels and the initial testing of the pump controller in our lab in NY. The following is a list of the most important activities from Q3 2014:

- ***Procurement (April – June 2014):***
    - ***AC pump controller:*** The long-awaited unit arrived from India in NY in late June. It weighs 80 kg (175 lbs) and yet despite its bulk and long shipping route, it arrived in relatively good shape. We are in the midst of testing it in our NY lab (see below).
    - ***Solar PV panels:*** The contract for the procurement and installation of 8kW of 200W Luxor solar panels was finalized and payment made to Soleil-Eau-Vie SARL in the month of June. Installation is expected to happen during the month of August.
    - ***Sub-award with Millennium Promise:*** A budget modification to include an $81,766 sub-award to Millennium Promise was approved by USAID. The sub-award will allow us to pay local MVP field staff and hire local consultants which have been challenges to us since project inception. The legal teams for The Earth Institute and Millennium Promise continue to discuss the payment terms but a finalized sub-award is expected before the end of July 2014.

- ***Smart-meter software testing (June 2014):*** The senior programmer, Denis Papathanasiou, continued to work with the existing Trinity smart-meters to make sure that they will be compatible with the AC pump controller and the Android-based payment system. He also began to work with Jack Bott, assistant technician, to experiment with other plug computer and communication protocol configurations. The most promising pathway so far seems to be using standard Modbus communication protocols to send data from the meters to a plug computer (SheevaPlug, Raspberry Pi, etc.) which will control switching. In the existing setup, data leaves the meters through an RS-485 connection and is sent to the plug computer via an RS-485 to Ethernet converter. Testing continues on the newly arrived unit and looks promising from the programmatic side.

- ***Testing of AC pump controller (June 2014):***
    - We have spent two weeks trying to understand exactly what this controller can do and whether or not it works as expected. There was no wiring diagram, spec sheet or instruction manual included with the shipment and so we have been on numerous skype and phone calls with the manufacturer to try to produce a wiring diagram and to troubleshoot the unit.
    - We replaced some damaged capacitors and shored up a lot of the components that had been jostled out of position during shipping.
    - We have decided to bypass the Programmable Logic Controller (PLC) that was included with the unit as we intend to use a small plug-computer in its place. The plug computer is more flexible and will be able to better serve our future needs. For the bypass, we are using a converter that can take the RS-485 input from the meters and transfer it to

Ethernet for our plug-computer. We continue to work with it so that we can eventually control the pumps programmatically without the PLC.

- The biggest technical challenge for the Indian-based company seemed to be the electromagnetic interference between the inverter, the meters, and the PLC. They added transformers to act as filters and we are still trying to verify their exact function in case we need to replace them in the field.

Figure 1. AC pump controller the day it arrived from India. Programmable logic controller, 8 individual pump meters and manual on/off switches are visible on the front panel.

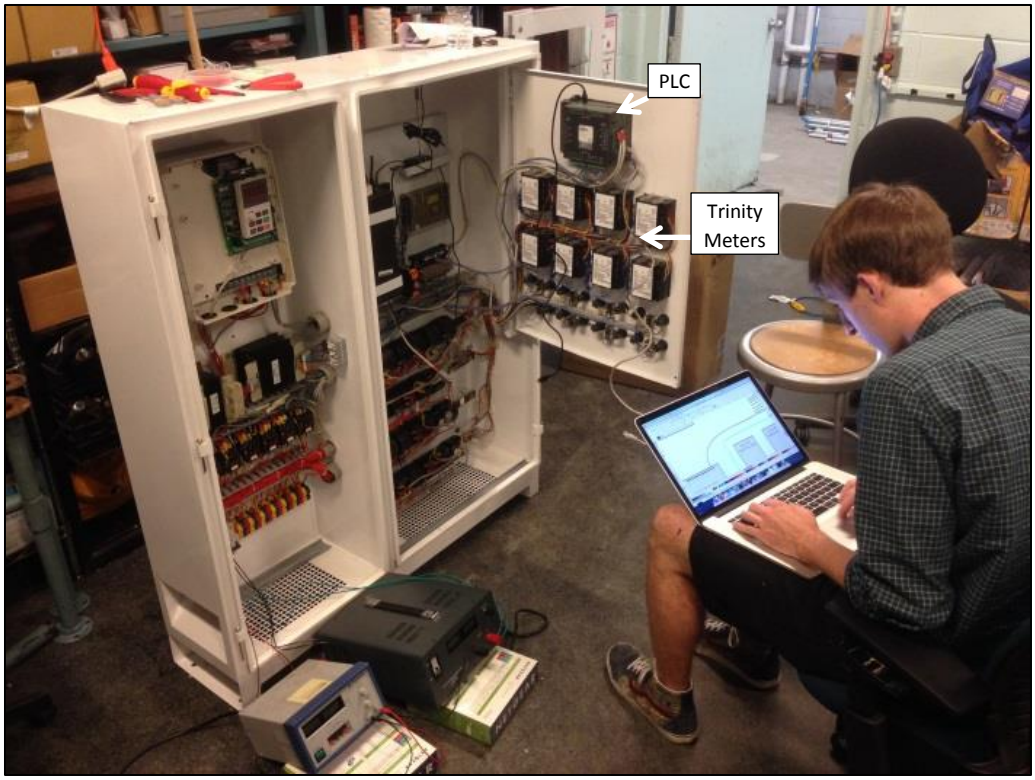

Figure 2. Jack Bott documenting the wiring layout for reference during testing.

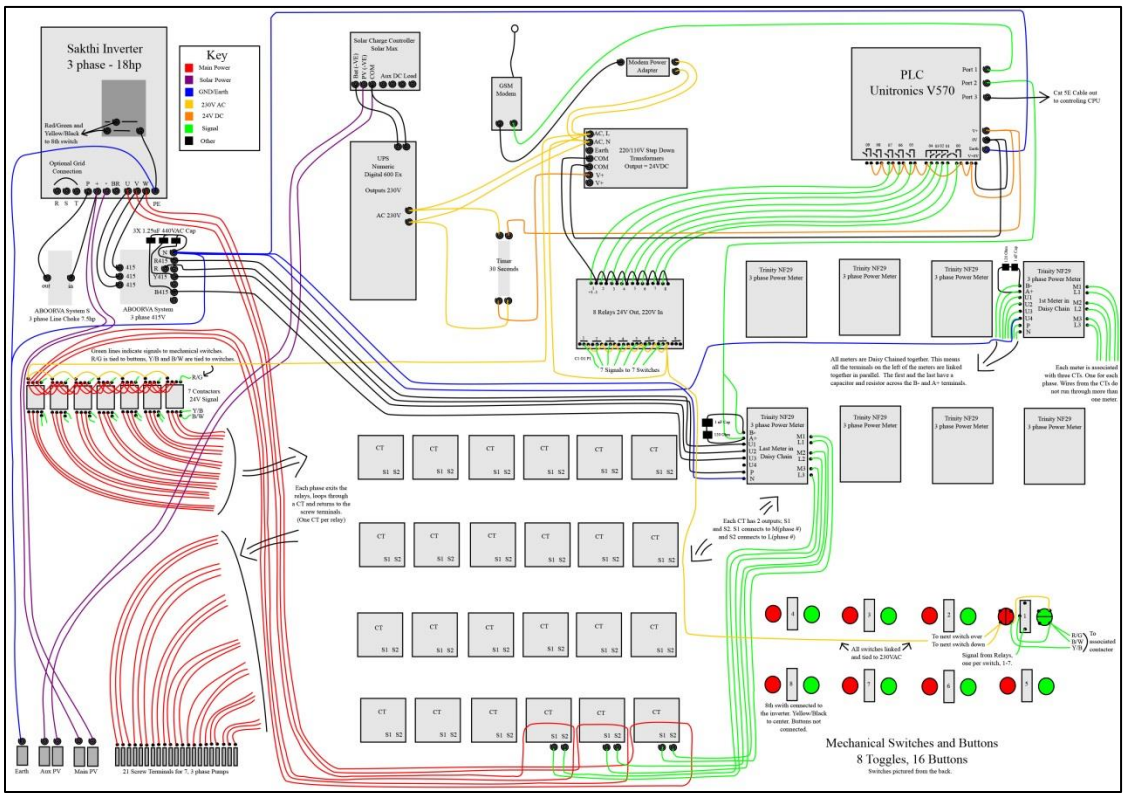

Figure 1. Reverse-engineered wiring diagram of AC solar pump controller

Figure 2. New capacitors installed to replace capacitors damaged during shipment.

Challenges:

We remain behind schedule due to the late arrival of the solar AC pump controller. Nevertheless, we anticipate that we will be able to figure out how it works and get it installed in the field during the next quarter, which still gives us a full year to test the first pilot installation and proceed with the other 2 pilots. The other procurement challenge of the MP sub-award seem to be getting resolved and this should help us to cover all of the field-based expenses related to the installation of the panels, the construction of the controller housing and the setting up of the controller.

With regard to the overall controls, we are still working to measure the total power available. Without a battery bank or charge controller to measure energy available, a new solution is required. A simulator has been constructed to mimic the behavior of the sun programmatically but the real behavior of the inverter and pumps is still unknown. The AC pump controller needs to easily adapt to fluctuations in power. The first field prototype will be used to experimentally verify the stability of the system so alterations can be made if necessary.

In terms of the technical challenges related to using one single PV array to provide power to multiple pumps, we will learn a lot in the coming weeks as we test the unit in NY. If the pump controller is able to do what we need, then we can easily install it in Senegal and begin to learn from the farmers how well it works in a field setting and make adjustments as needed. Should the controller not work however, we are exploring other options in parallel and we will be ready to roll out a plan B as soon as we are sure that that plan A will not work.